Amendments to the Drawings

In Figure 2, reference numerals 150 and 170 are replaced with 250 and 270, respectively. A Replacement Sheet for Figure 2 is included with this Amendment.

Remarks

Claims 1-9 are pending in the application. Claims 1-9 are rejected. All rejections are respectfully traversed. Claims 10 and 11 are new.

The drawings are objected to. Figure 1 shows an equalizer estimator 170 which estimates equalizer coefficients 171 from an equalizer training sequence 161 generated by an equalizer generator 160, as in amended claim 5.

The Specification is objected to. The Specification is amended to correct the informalities. No new subject matter is added.

Claims 1 and 9 are objected to. Claims 1 and 9 are amended to correct the informalities. No new subject matter is added.

A method estimates a channel impulse response in an ultra wide bandwidth (UWB) system. The FCC power spectral density emission limit for UWB emitters operating in the UWB band is −41.3 dBm/MHz. Because of these low emission limits, a typical DS-UWB device will have a total transmit power of about 1/10 mW, or about −10 dBm, across its entire signal bandwidth, and therefore the range of UWB signals is typically less than 20 meters.

Obviously, UWB signals cannot be used for conventional radio systems that use mobile receivers and base stations, see Banister and Rademacher, distinguished below.

Multiple different training sequences modulated at a chip rate are received. The training sequences consist of radio pulses, and not a continuous wave as in conventional radio systems. Each training sequence is sampled in parallel with multiple correlators at sampling rate substantially slower than the chip rate to obtain samples over a time interval corresponding to the impulse response at a resolution substantially equal to the chip rate. Then, the channel impulse response is estimated from these samples.

Claims 1, 4, 6 and 7 are rejected under 35 U.S.C. 102(a) as being anticipated by Banister, U.S. Patent No. 6,456,647 (Banister).

Banister is inappropriate art. The transmitters and receivers as described by Banister transmit and receive continuous wave DS-CDMA signals, see column 4, lines 28-32: "As another example, different fingers can be assigned to different transmitters, typically basestations, transmitting the same information symbols but distinguished by a code; this procedure is known as 'soft handoff.'"

By FCC regulations, UWB signals as claimed are not permitted for systems such as described by Banister.

In contrast, the claimed invention transmits and receives ultra wide bandwidth (UWB) signals. The UWB system as claimed uses extremely short electro-magnetic energy impulses, see Paragraph [04]-[011]. Nowhere in Banister is there any description of UWB impulse radio signals. Banister cannot anticipate what is claimed.

Banister transmits a single (continuous wave) pilot, see the consistent use of the *singular* "pilot signal":

"According to the invention, this cross correlation may be derived by filtering *a pilot signal*." Column 3, lines 6-8.

"*A pilot signal* is a signal transmitted to a receiver but also known a priori; the receiver may thus estimate the channel response by comparing *the received pilot signal* to the known value." Column 6, lines 57-60.

"Each of these initial estimates is multiplied by one of the weights w_i, which is derived from an estimate of *a pilot signal* P_i, as will be further described in Section III." Column 7, lines 1-4.

"As shown, the signal $u_{after}[n]$, which may be generated in the manner previously described, is provided to a multiplier **34** which multiplies $u_{after}[n]$ by the complex conjugate of *a pilot signal* p_0..." Column 7, lines 28-31.

"Finally, an alternative formula for the weights w_i is then derived for a DS-CDMA system that employs *a pilot signal*, which formula may be implemented by the filter **30** shown in FIG. 2." Column 9, lines 3-6.

"For a DS-CDMA system with *a pilot signal*, *the pilot signal* for signal path i may be used as the desired signal." Column 17, lines 18-19.

In contrast, the claimed invention transmits and receives in parallel a plurality of different training sequences, see Figure 7 and paragraph [029].

In Banister, the received signal at each antenna is identical, see Column 7, lines 49-51: "In a receiver with multiple antennae, the spacing of the antennae will result in different antennae receiving *the identical signal* at different times, as illustrated in FIG. 4." Again, note the use of a singular signal.

In light of the limitations distinguished above, Banister cannot anticipate the invention.

With respect to claim 4, nowhere does Banister describe sampling a UWB signal at a symbol rate.

With respect to claim 6 and as stated above, Banister does not receive impulse radio signals.

With respect to claim 7, the samples include two subsets of samples: a first subset used for a rough estimate, and a second subset for an accurate estimate.

At column 12, Banister states:

> If a pilot signal p[n] is transmitted, and the receiver "knows" the exact value of the pilot signal, then according to the present invention, the desired signal $v_i[n]$ for a user i may be taken as equal to the pilot signal $p_i[n]$ for that user, in which case, $w_i[n]$ becomes
>
> $w_i[n]=(1-\lambda)\cdot z_i[n]$, where
>
> $$z_i[n] = \sum_{k=-\infty}^{n} \lambda^{n-k} u_{after}[k] p_i*[k] = \lambda z_i[n-1] + u_{after}[n] p_i*[n]$$

Here, Banister estimates a set of weights $w_i[n]$ from a set $z_i[n]$, where $z_i[n]$ is derived from a sum of a vector of samples $u_{after}[k]$, see column 2, lines 53-63: "These and other needs are met by the present invention. According to an embodiment of the invention, a DS-CDMA receiver receives an input signal which comprises a plurality of received signals that are received over a corresponding plurality of antennae. These signals are demodulated and sampled to create digital signals, which may be represented by a vector $u_{before}[n]$, which has one element for each of the plurality of input signals. The vector $u_{before}[n]$ is decorrelated by multiplying it with a decorrelation matrix to create a vector $u_{after}[n]$ which thus represents a modified version of the input signal."

In the above, Banister only describes a single set of weights and a single set of samples.

The Examiner states that "z_i is a summation of k and can be considered partial values to obtain the accurate (complete) estimate." It is unclear what the Examiner means by "a summation of k can be considered partial values." In addition, the invention does not claim 'partial values'.

Certainly, a sum of samples cannot be a subset of the samples. With all due respect, the Examiner's analysis that z_i includes a first subset of samples for rough estimation, and a second subset of samples for an accurate estimate is erroneous.

Claims 2, 3 and 8-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Banister.

In claim 2, each training sequence is passed through n correlators to generate n samples for each correlator. As stated above, Banister neither teaches impulse radio signals nor a plurality of training sequences.

In claim 2, the sampling rate is at least ten times slower than the chip rate. There is nothing in Banister that describes the sampling of different training sequences consisting of radio pulses at any rate.

Banister does not describe estimating the impulse response based on a previous impulse response of an impulse radio signal as in claim 8. Nor does Banister describe correlators for UWB signals.

Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Banister in view of Rademacher, U.S. Patent No. 6,570,918 (Rademacher).

Rademacher is also inappropriate art. Rademacher is only concerned with conventional continuous wave, spread spectrum radio signals in cellular networks that use mobile receivers and fixed base stations. Rademacher, in combination with Banister, does not teach a method for estimating a channel impulse response in a UWB system that uses impulse radio signals.

In claim 5, the method estimates equalizer coefficients from an equalizer training sequence consisting of radio pulses. Rademacher does not describe equalizer training sequences consisting of UWB radio pulses. In fact, Rademacher does not even teach equalizer training signals.

It is believed that this application is now in condition for allowance. A notice to this effect is respectfully requested. Should further questions arise concerning this application, the Examiner is invited to call Applicant's attorney at the number listed below. Please charge any shortage in fees due in connection with the filing of this paper to Deposit Account 50-0749.

Respectfully submitted,
Mitsubishi Electric Research Laboratories, Inc.

By

/Clifton D. Mueller/

Clifton D. Mueller
Attorney for the Assignee
Reg. No. 57,836

201 Broadway, 8th Floor
Cambridge, MA 02139
Telephone: (617) 621-7517
Customer No. 022199